General Radio



# TYPE 1025-A STANDARD SWEEP-FREQUENCY GENERATOR

## General

The 1025-A is an important contribution to the field of instrumentation for sweep measurements. Presently available sweep sources have the same relationship to the 1025-A as an oscillator does to a standard-signal generator. The 1025-A provides the excellent electrical performance and calibrated outputs expected from a signal generator while other sweep sources are deficient in one or more respects.

Any of the octave ranges covered by the standard instrument can be replaced with one or more special "bandspread" ranges (up to 50 Mc) tailored to suit the needs of a particular user.

## Timing

The 1025-A will be available approximately 4th Q, 1962.

## Features (Refer to Figure 1)

1. Can be operated as a CW generator for point-by-point investigations of small portions of the response spectrum; as a slow speed sweep generator with accessory dial drive for X-Y recorder plots; and as a fast sweep generator for oscillographic presentation of response.

2. Frequency range of 0.7 Mc to 230 Mc is covered in ten approximately octave ranges with two additional standard bandspread ranges covering 10.7 $\pm$ 0.3 Mc and 0.4 to 0.5 Mc.

3. Output is 1.0 $\mu$v to 1.0 v full scale behind a 50 ohm source impedance.

4. Provides a sharp, continuously variable marker pip accurately calibrated in both amplitude and frequency.

5. Swept frequency output is accurately metered and attenuated. A high quality AVC circuit maintains output level constant within $\pm$0.25 db.

6. Virtually free from harmonic distortion, spurious outputs, and frequency drift.

7. Logarithmic sweep provides constant percentage frequency resolution when full sweep bandwidth is displayed. For detailed investigations, display can be expanded up to 10:1 about any desired frequency providing a nearly linear display.

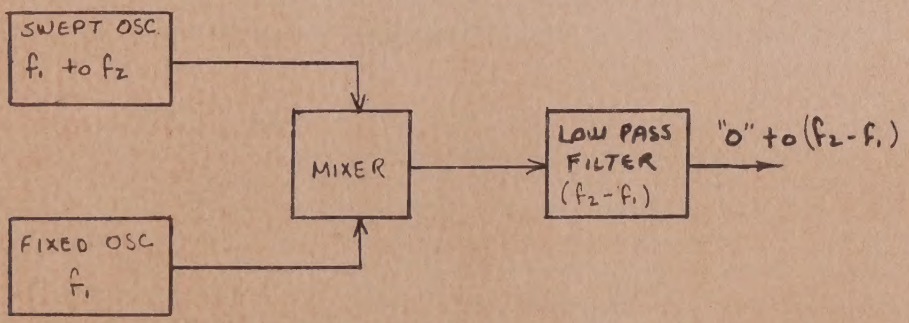
8. Swept oscillator is "turned off" during retrace, providing automatic base line and eliminating blanking adjustments. Horizontal voltage supplied to the oscilloscope is automatically synchronized to the frequency sweep, eliminating the need for phase adjustments.

Background

Since the 1025 represents a new area of instrumentation for us, some general information on sweep instrument design, important features, and measurement techniques is appropriate. Time will be available for a further discussion of these and other points during Sales Week.

Most sweep oscillators presently on the market use one of two methods to vary the oscillator frequency:

Saturable Reactor: One method uses a saturable reactor as the oscillator tank circuit inductance. Operating the reactor in the curved region of the B-H loop permits the effective inductance to be varied by applying a low frequency current to a separate magnetizing coil. Frequency shifts up to approximately ±40% of the center frequency can be obtained in this fashion, allowing a swept frequency coverage of approximately 2:1 up to frequencies of approximately 50 Mc. Above 50 Mc progressively smaller percentage shifts are possible. The Q of such a resonant circuit is fairly low (generally 20 to 50) resulting in poor frequency stability. The inductance is also affected by temperature, and the frequency drifts as the instrument warms up. Residual currents in the coil from hum pickup, etc., cause small frequency shifts even when the sweep width is reduced to "zero", and therefore true CW operation is impossible. Several octaves of frequency can be covered using separate reactors for each octave with continuous coverage in a given octave provided by a variable capacitor. To sweep over greater than octave ranges, a heterodyne technique (similar to that used in the 1300) is used. A block diagram of the general scheme is shown below.




If $f_1$ = 300 Mc
$f_2$ = 400 Mc
Swept output is from "zero" to 100 Mc.

Although a wide range is obtained by this technique, the stability problem is aggravated since the effect of drift in the sweep oscillator is multiplied by the heterodyning process. In addition, spurious outputs are generated in the mixer, since harmonics of both the sweep oscillator and local oscillator are present and can combine to give unwanted beats in the desired sweep frequency range. Since the saturable reactor absorbs considerable power from the swept oscillator, the available output level is fairly low even when used directly and is further reduced by the insertion loss of the mixer when the heterodyne scheme is used.

Vibrating Capacitor: The second method uses a vibrating capacitor or "wobbulator". The tank circuit capacitance is varied by varying the "meshing" of capacitor plates using a driving coil similar to a speaker voice coil with one of the capacitor plates mechanically connected to the coil. As in the case of the saturable reactor, frequency shifts up to ±40% of the center frequency can be obtained. Again, true CW operation is not possible since there is always some residual vibration or coil current causing small frequency changes. The tank circuit Q is high, and the frequency stability, therefore, is better than the saturable reactor type. Very wide sweeps can be obtained using the heterodyne technique, with the same disadvantages.

Since an electrical signal controls the oscillator frequency, both methods inherently provide a simple means of adjusting the oscillator center frequency and sweep width. It is also possible to provide adjustable sweep rates, but because of the large amounts of power required, only a few instruments provide this feature. Most sweep at a 60 cycle rate, since the power can be obtained directly from the line, and the mechanical arrangement can be adjusted to resonate at 60 cycles.

Despite the obvious appeal of such controls, the non-linear nature of the driving mechanism makes it extremely difficult to provide accurate, dependable calibration of the controls, and presently available sweep sources do not provide them. Other means of calibrating the resulting frequency display (generally crystal markers) are required. Often an external output voltmeter and/or attenuator is required to calibrate the output voltage level. Although very useful, these devices are not in themselves precision instruments. They are roughly analagous to early oscilloscopes which offered only approximate calibrations of vertical gain and sweep time, which even when calibrated externally were not always sufficiently stable to be relied upon.

The important features of a standard sweep-frequency generator as opposed to a sweep oscillator are:

(1) The ability to produce a stable pattern which can be accurately calibrated in both frequency and amplitude without resort to additional equipment.

(2) The response displayed should be the true fundamental frequency response. If spurious outputs, harmonics, etc., are present in the signal fed to the device under test, the response displayed on the scope might well be meaningless.

(3) It should be capable of true CW operation so that a particular portion of the response can be carefully investigated.

(4) The leakage should be held to sufficiently low levels to enable microvolt signals to be fed to devices such as receivers, etc.

(5) It should be convenient to use as a CW, slow speed, or fast sweep instrument with a minimum of adjustment required to display the response and/or switch from one mode to another.

Certain basic techniques should be followed to avoid erroneous measurements when using sweep instruments:

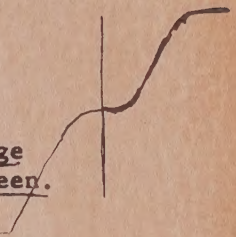
(1) If a narrow band device is swept too fast, errors will occur in the magnitude, frequency, and effective bandwidth of the displayed response. The rate at which such a device may be swept is proportional to the square of its bandwidth. Since the sweep rate of the 1025-A is fixed (20 sweeps/sec), care must be taken to insure that on a given sweep range the sweep speed (in cps/sec) does not exceed the limitations imposed by the bandwidth of the device under test. This will be carefully covered in the specifications for the 1025-A. In many cases, special bandspread ranges can be provided when the sweep speed of a standard octave range is excessive for a particular application.

(2) If the device under test has a very high rejection at frequencies removed from the response center frequency (the skirts), care must be taken, since the sweep output voltage level may be increased to a point allowing adequate display of the skirts but overloading the device in the mid-band region, with consequent distortion of the over-all response.

(3) Although crystal markers are not normally required with the 1025-A, they are used by most sweep oscillators and can be used in the 1025-A. Feeding the crystal oscillator frequency into the device under test to obtain the beat marker should be avoided, since the

response can be distorted. In the 1025-A and most sweep oscillators, a separate sample of the sweep output is available for heterodyning against the crystal oscillator, and the resulting beat is added to the output of the device under test for display purposes. If the bandwidth of the filter used to pass the marker beat note is narrow and the sweep speed high, the marker pip can be delayed in time by the filter and appear at an incorrect position on the display, giving an erroneous frequency calibration.

(4) The response detector can be operating in the square law, linear, or transition region of its transfer characteristic, depending upon the rf voltage level applied to it. The dc voltage out of the detector can, therefore, be proportional to the rf voltage (linear region), rf power (square law region), or something in between. To prevent misinterpretation of the vertical display, the transfer characteristic of the detector should be checked by changing the rf level a known amount and observing the change in vertical display.



## Technical Description

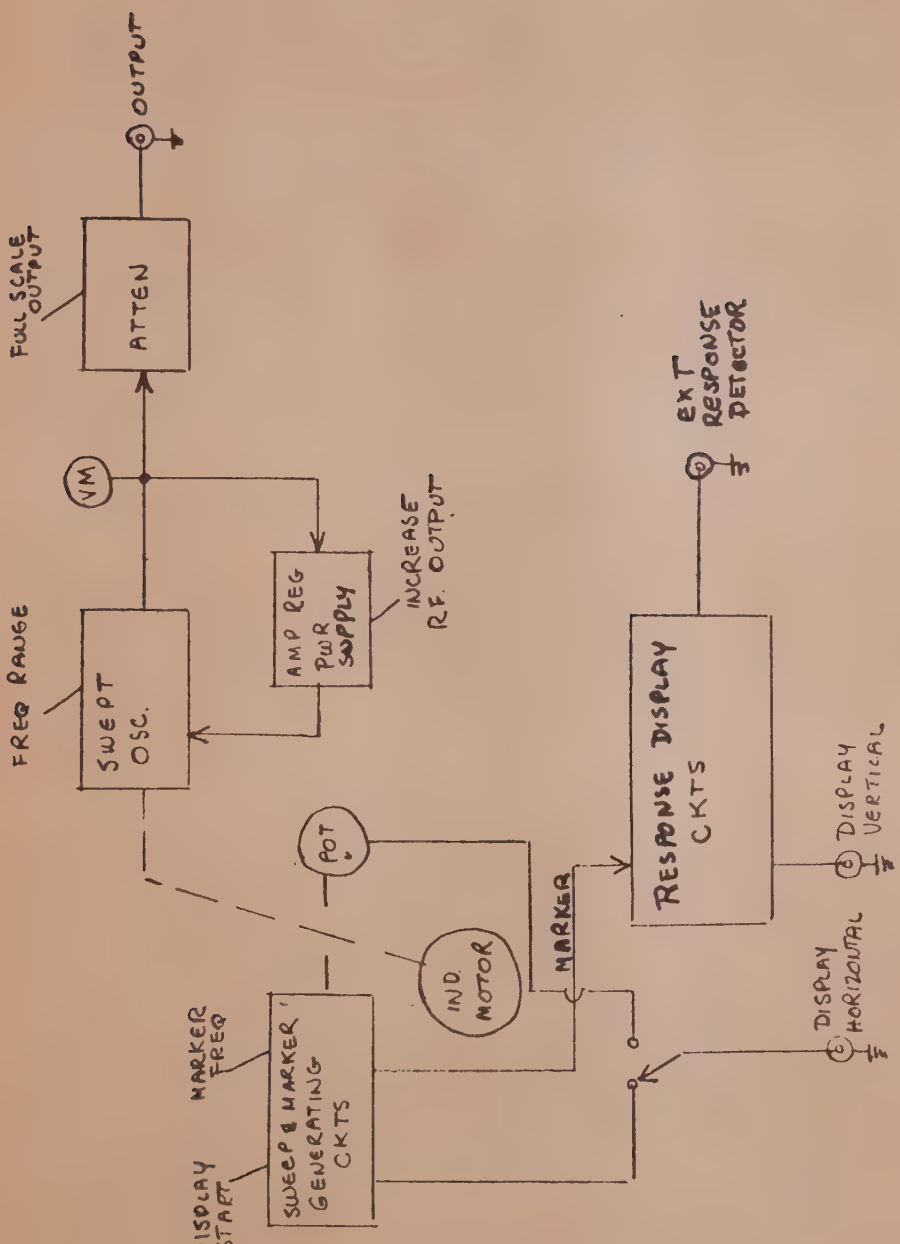
The 1025-A is intended to provide the performance expected from a standard-signal generator. It is designed as a standard-signal generator and uses a motor-driven variable air capacitor to provide the swept frequency. This technique provides an output which has a high amplitude, is free from harmonic distortion and spurious responses, and is extremely stable. It also makes possible the generation of a clean, sharp marker which can be continuously varied in amplitude and frequency and is accurately calibrated in both respects.

The capacitor plates are shaped to provide a logarithmic change in capacitance with rotation, resulting in a logarithmic frequency sweep. Although the sweep center frequency and width cannot be adjusted, the same effect can be achieved using the display expansion controls, provided the maximum permissible sweep speed (cps/sec) of the device under test is not exceeded. As shown in Figure 2, the instrument consists of (1) an oscillator, voltmeter, and output attenuator; (2) the amplitude-regulating power supply (AVC circuit); (3) sweep and marker generating circuits; and (4) the response display circuits.

The oscillator is tuned to a given range by changing the tank circuit inductance. The oscillator output is metered by a peak reading VTVM and fed to the output connector through a step attenuator covering a range of 120 db in 10 db steps.

The output level is regulated by an amplitude-regulating power supply (similar in principle to the 1263), which compares the detected rf output to an adjustable reference voltage and uses any difference existing to correct the oscillator plate voltage.

FIGURE 2


OUTPUT
FULL SCALE OUTPUT
ATTEN
VM
INCREASE R.F. OUTPUT
AMP REG PWR SUPPLY
FREQ RANGE
SWEPT OSC.
EXT RESPONSE DETECTOR
RESPONSE DISPLAY CKTS
POT
IND. MOTOR
MARKER
DISPLAY VERTICAL
DISPLAY HORIZONTAL
MARKER FREQ
SWEEP & MARKER GENERATING CKTS
DISPLAY START

Fast Sweep: The fast frequency sweep is generated by an induction motor operating at 1675 rpm. A pulley arrangement reduces the speed to 1200 rpm, or 20 rps. The pulley connected to the tuning capacitor shaft has three pole pieces, two placed at one point on the pulley diameter and the other placed 180° from the first set. A sketch of the arrangement is shown in Figure 3. The motor, in addition to sweeping the capacitor through its tuning range (180° of capacitor rotation sweeps the frequency from low to high and the remaining 180° returns it from high to low) 20 times per second, also rotates the pole pieces at the same rate.

Three sets of coils are placed outside the periphery of this pulley, arranged so that the rotating pole pieces pass under the coils. One coil set is fixed in location. The other two may be moved independently around the periphery over a 180° arc. Each time a pole piece passes under a coil set, a pulse is generated. The pulses generated in the three coil sets are used to: (1) turn off the sweep generator on the return trace, (2) provide the frequency marker and (3) generate the sweep voltage applied to the horizontal axis of the display oscilloscope.

The fixed coil set generates two pulses per revolution of the pulley since two sets of pole pieces pass under it per revolution. One pulse is used to turn the oscillator on, and the next pulse, occurring when the second set of pole pieces pass under the coil, is used to turn the oscillator off. This fixed coil is physically located so that the tuning capacitor is just starting through its useful (low to high frequency sweep) 180° of rotation when the generator is turned on and is just starting on its return half cycle when the generator is turned off.

One of the movable coil sets can be rotated through a 180° arc by the knob which controls the marker frequency. The single pole piece which passes under this coil set only during the return half cycle of the tuning capacitor rotation (sweep generator off) generates a pulse which is used to form the marker (a single pulse per revolution of the tuning capacitor). Although the marker is formed during the return half cycle of the sweep, it can be calibrated in terms of the frequency of the oscillator during the operating half cycle. The angular position of the marker coil determines the instant at which the marker is generated. This time corresponds to a particular position of the tuning capacitor and, therefore, a particular frequency of the swept oscillator. Thus the angular position of the coil may be calibrated directly in terms of frequency.

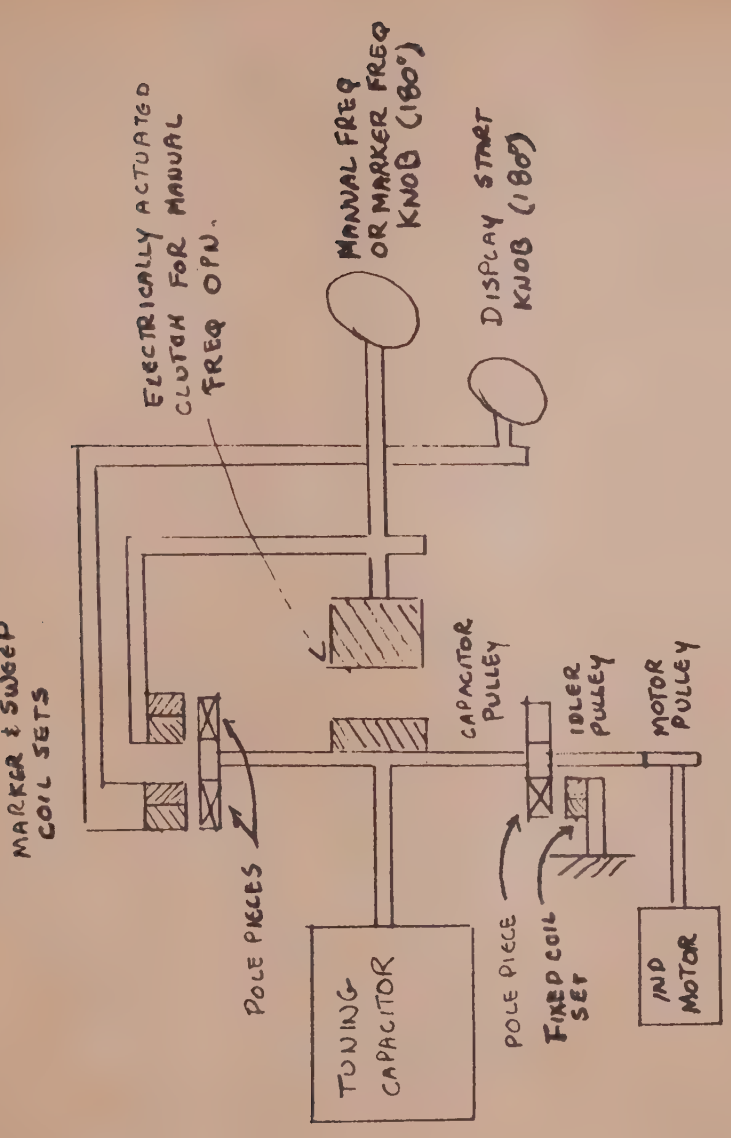

ELECTRICALLY ACTUATED CLUTCH FOR MANUAL FREQ OPN.
MANUAL FREQ OR MARKER FREQ KNOB (180°)
DISPLAY START KNOB (180°)
MARKER & SWEEP COIL SETS
CAPACITOR PULLEY
IDLER PULLEY
MOTOR PULLEY
POLE PIECES
TUNING CAPACITOR
POLE PIECE
FIXED COIL SET
IND MOTOR

FIGURE 3

The other movable coil set is rotated over a 180° arc by the knob which starts the sweep display. Each time a set of pole pieces pass under this coil set (twice per revolution of the tuning capacitor), a pulse is generated which is used to form a sweep voltage. Two sweeps are generated per revolution of the tuning capacitor.

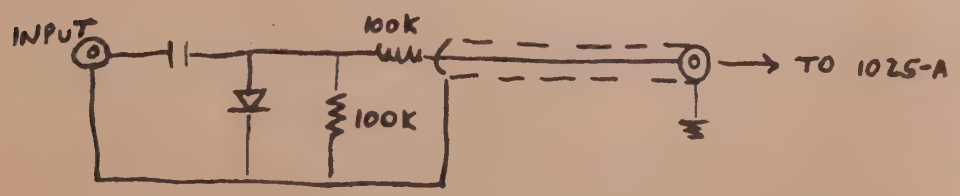
The time relationships of these elements are shown in Figure 4. The first of the two sweeps generated per revolution of the tuning capacitor starts during the operating half cycle (180°) of the tuning capacitor rotation and is used to display the response of the device under test on a scope. The second sweep starts during the non-operating (oscillator turned off) half cycle of the tuning capacitor rotation and is used to display the marker on the scope.

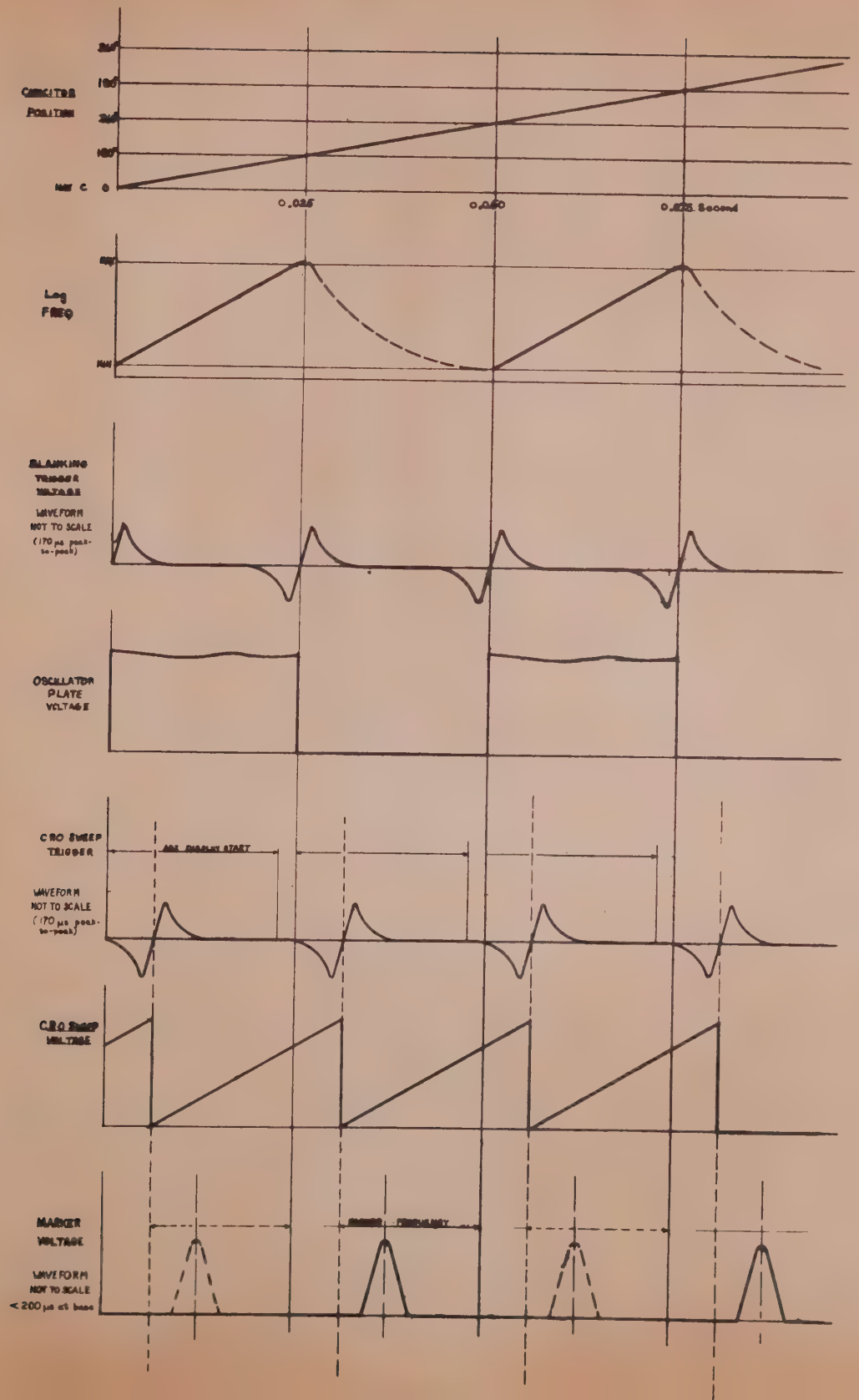
By rotating this coil set over the 180° arc, the first sweep can be started at any point on the operating half cycle of the tuning capacitor rotation, and the scope displays only that portion of the response beginning at a frequency corresponding to this point. The second sweep starts at a corresponding point on the non-operating half cycle for display of the marker pulse. Expansion of the display can be obtained by increasing the slope of the sweep voltage applied to the scope. The display starts at an instantaneous sweep frequency determined by the point at which the sweep is started (zero deflection voltage) and ends at a frequency where the sweep voltage deflects the scope off scale. Since the sweep repetition rate is 20 per second, the device response and marker are each displayed 20 times per second on the scope and appear to be superimposed. Note that only the scope display is affected by these controls--the device under test is always swept over the complete range of the frequency band selected.

takes the place of adjustable center freq & width

The envelope of the response of the device under test can be detected in any of three ways:

(1) The 1025-P1 Probe can be used where a relatively high (30 k) input impedance is required to prevent loading the device under test.




0.025
0.050
0.075 Second
Lag Freq
BLANKING TRIGGER VOLTAGE
WAVEFORM NOT TO SCALE
OSCILLATOR PLATE VOLTAGE
C.R.O. SWEEP TRIGGER
WAVEFORM NOT TO SCALE
C.R.O. SWEEP VOLTAGE
MARKER VOLTAGE
WAVEFORM NOT TO SCALE

(2) The 874-VQ (with 874-WM) can be used where a 50 ohm input impedance is desired.

(3) If a detector is part of the device under test, its dc output can be used directly. A minimum of 6 mv is required for a scope deflection of 1 cm (assuming 50 mv/cm scope sensitivity).

The dc output obtained from the detector is fed to the response detector input of the 1025 where it is added to the marker pulse, amplified, and fed out to the vertical input of the display scope. The sweep voltages are generated, amplified and fed out to the horizontal input of the display scope.

Manual Sweep: In this mode, the sweep generating circuit is disabled and the same horizontal voltage previously provided by the sweep generating circuit is generated by a built-in potentiometer. The horizontal voltage is amplified by the same sweep amplifier stage used for fast sweep, and therefore the same voltage level is provided to the display scope. No adjustments are required when switching from the fast sweep mode to the manual sweep mode. The frequency for any position of the main frequency control is indicated by the position of the hairline on the main frequency scale.

Slow Speed Sweep: Slow sweeps are generated by removing the main frequency knob and using the accessory 908-P3 dial drive to rotate the tuning capacitor. The built-in pot also provides the horizontal voltage in this mode, and the same horizontal and vertical output connectors are used to provide the inputs to an X-Y plotter or long persistence scope. The dial drive is arranged so that when turned on it will drive in one direction until a mechanical stop is encountered and will not reverse until a lever at the top of the dial drive is pushed. Adjustable upper and lower mechanical stops are provided on the 1025-A.

How to Use (Refer to Figure 5)

Connect the input of the device under test to the 1025-A OUTPUT connector, and the output of the device under test to the 1025-P1 Detector Probe or other external rf response detector. If the device under test has a built-in detector, its dc output can be directly supplied to the 1025-A. Connect the output of the detector to the 1025-A EXTERNAL RESPONSE DETECTOR connector. Connect the DISPLAY HORIZONTAL and DISPLAY VERTICAL outputs to the inputs of the display scope or X-Y plotter, and turn on the instrument.

Output from Type 1213-C Unit Time/Frequency Calibrator can be connected here to add frequency markers to display in MANUAL OPERATION (not suitable for sweep operation with Type 1213-C).

Scale can be shifted to match external frequency calibrator to increase absolute frequency accuracy.

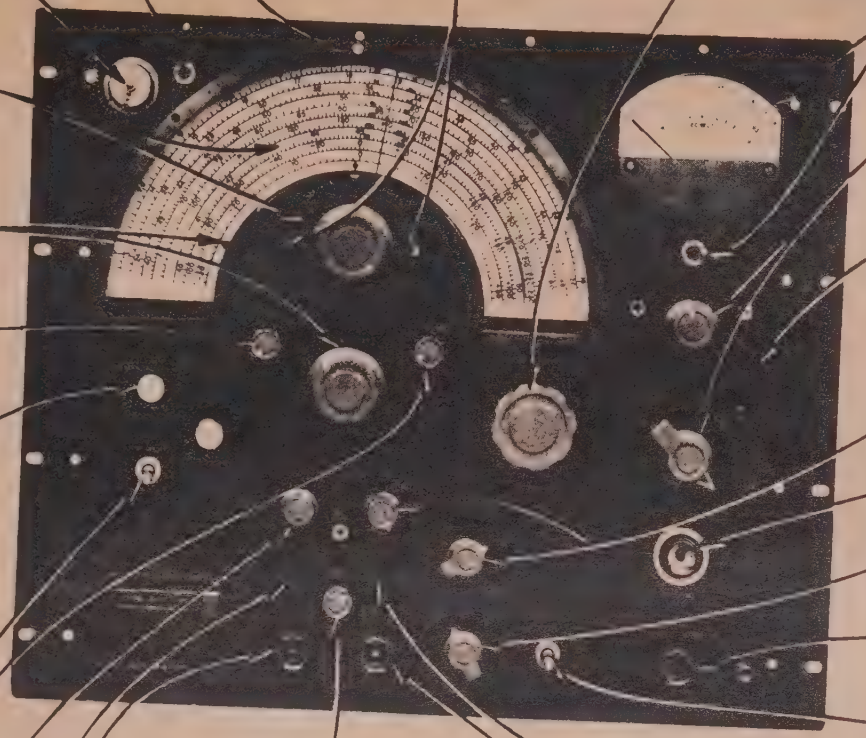
Selects FREQUENCY RANGE that covers frequency band to be displayed. Display can be expanded to show only position of selected FREQUENCY RANGE if desired.

Connection to frequency calibrator such as Type 1213-C or counter for highly accurate CW frequency with MANUAL OPERATION. At least 0.1 volt available at all RF OUTPUT levels.

Remove these screws to replace incremental dial and knob assembly with Type 908-P2 Synchronous Dial Drive. Provides slow-speed sweeping in MANUAL OPERATION mode.

Indicates MARKER AMPLITUDE or RF OUTPUT as selected by METER INDICATES switch below. Full-scale levels are selected by the FULL SCALE OUTPUT switch and the MARKER AMPLITUDE FULL SCALE switch.

Frequency scales and control knob with incremental dial. Octave ranges are logarithmic and one small division equals 0.1 percent. Bandspread ranges have essentially linear frequency scales. Read scale corresponding to FREQUENCY RANGE selected. Dial indicates MARKER FREQUENCY in sweep mode and CW FREQUENCY in manual mode as selected below.



Set RF OUTPUT level. INCREASE RF OUTPUT control provides continuous level variation in conjunction with 10 db per step attenuation of the FULL SCALE OUTPUT switch. For best accuracy the FULL SCALE OUTPUT setting that gives the desired output at the highest meter indication should be used.

When it is desired to display only a portion of a selected FREQUENCY RANGE, the low frequency or left side of display may be set anywhere in the frequency range by this control, and the EXPAND DISPLAY control advanced to set the high frequency limit of the display. The small pointer indicates the approximate low frequency limit (DISPLAY START).

Set RF OUTPUT meter indication to zero with INCREASE RF OUTPUT control fully counterclockwise (off).

Locks DISPLAY START to prevent accidental shift and to make it serve as lower limit stop when Type 908-P2 Dial Drive is used.

Set MARKER AMPLITUDE. INCREASE MARKER AMPLITUDE control provides continuous amplitude variation in conjunction with 10-db step attenuation of MARKER AMPLITUDE FULL SCALE switch. With linear RESPONSE DETECTOR the marker peak can be matched to various portions of the display to determine relative amplitudes. Thus the display can be calibrated in both amplitude and frequency.

Select manual or sweep operation. In manual mode a dc voltage proportional to dial position is provided at DISPLAY HORIZONTAL connector, maintaining the sweep display for slow sweeping for use with X-Y plotter or oscilloscope. The DISPLAY START and EXPAND DISPLAY control functions are maintained so that manual sweep display closely matches the display with normal sweep. After pushing control for manual operation rotate knob slowly until click is heard and resistance felt. In normal sweep operation (PULL) the selected FREQUENCY RANGE is swept in 22 milliseconds with repetition rate of 20 per second.

RF output to device under test. Matching 50-ohm source impedance for Type 874-R22 cable.

Sets input sensitivity, to avoid overload. Multiply MARKER AMPLITUDE voltage or add decibels to get corresponding level at EXTERNAL RESPONSE DETECTOR connector.

Turns instrument on. Fuses and power receptacle in rear of cabinet. 115 v 60~ can be changed to 230 v and/or 50~.

Connection to Type 1025-P1 Detector Probe or other external rf response detector by shielded cable. Type 874 patch cords recommended.

Set for "response-up" display with either positive or negative polarity response detector.

When driving dial with Type 908-P2, release and lock when the desired upper frequency limit is reached. Can be reset while frequency indicator is moving. Provides reversing stop for dial drive but can also be used in manual operation.

Adjust for negligible shift in DISPLAY VERTICAL output as RESPONSE POLARITY is switched with no input from EXTERNAL RESPONSE DETECTOR.

Adjust for zero base-line output from DISPLAY VERTICAL connector. Permits vertical sensitivity of oscilloscope or X-Y plotter to be changed without shifting display zero or base line.

This control sets the horizontal size of the display by controlling the DISPLAY HORIZONTAL voltage. 100 volts peak-to-peak is available, which permits 1/10 of a selected FREQUENCY RANGE to be expanded to full scale with oscilloscope or X-Y plotter full-scale horizontal sensitivity of 10 volts.

Connection to oscilloscope or X-Y plotter horizontal input. Sensitivity should be 10 volts full scale or better. Response of oscilloscope must be good from dc to 100 kc for use with normal sweep.

Connection to oscilloscope or X-Y plotter. Vertical input sensitivity down to 0.2 volt full scale is useful, giving a maximum full-scale sensitivity of 0.025 volt at the EXTERNAL RESPONSE DETECTOR connector. Response of oscilloscope must be good from dc to 100 kc for use with normal sweep.

Adjust for negligible shift in left edge of display as EXPAND DISPLAY control is varied.

FIGURE 5

Fast Sweep Operation: Pull out the CLUTCH control. Rotate the DISPLAY START knob full CCW, and adjust EXPAND DISPLAY knob until the 1025-A horizontal sweep voltage produces full scale deflection of the display oscilloscope. The response of the device under test over the complete octave range selected by the FREQUENCY RANGE switch should now be displayed. By rotating the MARKER FREQUENCY knob, the marker displayed on the scope can be adjusted to any desired position. To calibrate the marker amplitude, throw the METER INDICATES switch to MARKER AMPLITUDE and adjust the MARKER AMPLITUDE FULL SCALE switch and the INCREASE MARKER AMPLITUDE control to set the desired level. The marker frequency is read from the position of the index line on the main frequency scale.

To expand the display about any given frequency in the range, set the marker to this frequency with the MARKER FREQUENCY knob and adjust the DISPLAY START knob until the marker appears at the left edge of the scope screen. The display can be prevented from shifting by adjusting the LOCK DISPLAY START knob. Set the marker frequency to the desired upper frequency limit of the expanded display and adjust the EXPAND DISPLAY control until the marker appears at the right-hand edge of the scope screen. The frequency of any point on the expanded display can be determined by adjusting the MARKER FREQUENCY knob until the marker is coincident with this point and reading the frequency from the main frequency scale.

The relative amplitude of any two points can be determined by adjusting the marker amplitude to correspond with these amplitude points and recording the value of the marker amplitudes. Since the marker is added to the response display after the detector probe, it is always linear in voltage. The detector law (which depends upon rf voltage level) may easily be checked using the output voltmeter and attenuator. Many sweep oscillators lack a voltmeter and/or attenuator, and checking the detector transfer characteristic is much more difficult.

Manual Sweep (CW): Push and rotate the CLUTCH control knob until a click is heard. Set the frequency range with the FREQUENCY RANGE switch and adjust the output to the desired level using the RF OUTPUT control and the OUTPUT attenuator.

An important feature of this instrument is the auxiliary FREQUENCY output which can be used to operate a counter or any external frequency meter or calibrator for highly accurate indications of frequency. Normally extremely steep response slopes are investigated in the manual mode, and the precise frequency readout from the counter is an important aid in measuring the amplitude vs. frequency response. Measurements of this type require good frequency stability such as is provided by the 1025-A. The SCALE CORRECTOR thumbscrew may be used to

adjust the main frequency scale hairline for precise agreement with the frequency as indicated by the counter. Adjust the RESPONSE AMPLITUDE MULTIPLIER switch for a convenient vertical presentation on the display device, observing the maximum input level restriction indicated on each switch position to prevent overloading the internal vertical response amplifier. Adjust the VERT BAL control and the HORIZONTAL ZERO and VERTICAL ZERO controls for a suitable presentation (not normally required after initial setting). If a scope is used as the display device, a single dot appears on the screen whose vertical position corresponds to the amplitude of the device response and whose horizontal position corresponds to the 1025 output frequency.

As long as the detector operates in the linear region of its characteristic, the vertical display is linear in voltage. Typically, if the rf input to the 1025-P1 Detector Probe is less than 50 to 100 mv, the detector response is square law and the vertical display is then linear in terms of power. The type of response being displayed may be checked by increasing or decreasing the rf output to the device under test by a known amount, using the output attenuator and meter and observing the change in vertical response on the scope.

Slow Speed Sweep: Push in the CLUTCH control and rotate until a click is heard. Remove the FREQUENCY knob and dial assembly, replacing it with the 908-P3 Synchronous Dial Drive. The portion of the range to be swept with the dial drive can be set using the LOCK DISPLAY START and LOCK UPPER LIMIT knobs. Turn the dial drive on and push the operating lever. If a scope is still being used, no vertical or horizontal display adjustments should be necessary. An X-Y plotter will require horizontal and vertical gain adjustments. This mode is primarily useful in production testing where repetitive tests are made and a permanent record desired. Otherwise the same information can be obtained more conveniently using manual operation.

In any of the operating modes an external crystal marker can be added to the scope display by using the auxiliary FREQUENCY output with a 1213-C or similar device feeding the beat output to the EXTERNAL MARKER jack. The internal marker is automatically disconnected when the EXTERNAL MARKER jack is used. Care should be taken to insure that the bandwidth of the beat amplifier is sufficient to prevent a delay in the presentation of the crystal marker pip (on Fast Sweep mode bandwidth of 1213-C internal beat amplifier is insufficient).